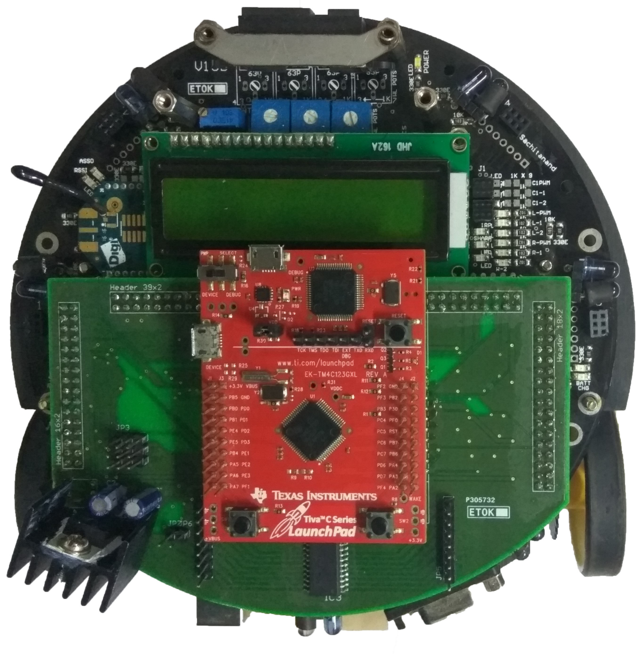
Tiva Based Daughter Board for Firebird V Hardware and Software Manual

ERTS Lab IIT Bombay

July 8, 2017



1 Credits

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2 Notice

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3 Introduction

Tiva Daughter board for Fire Bird V will help you gain exposure to the world of robotics and embedded systems with ARM Cortex M4. The board is designed with Open Source Philosophy in software and hardware design ,you will be able to create and contribute to complex applications that run on this platform, helping you acquire expertise as you spend more time with them.

3.1 Safety precautions:

- Robot's electronics is static sensitive. Use robot in static free environment.
- Read the assembling and operating instructions before working with the robot.
- If robot's battery low buzzer starts beeping, immediately charge the batteries.
- To prevent fire hazard, do not expose the equipment to rain or moisture.
- Refrain from dismantling the unit or any of its accessories once robot is assembled.
- Charge the NiMH battery only with the charger provided on the robot.
- Never allow NiMH battery to deep discharge.
- Mount all the components with correct polarity.
- Keep wheels away from long hair or fur.
- Keep the robot away from the wet areas. Contact with water will damage the robot.
- To avoid risk of fall, keep your robot in a stable position.
- Do not attach any connectors while robot is powered ON.
- Never leave the robot powered ON when it is not in use.
- Disconnect the battery charger after charging the robot.

3.2 Inappropriate Operation:

Inappropriate operation can damage your robot. Inappropriate operation includes, but is not limited to:

- Dropping the robot, running it off an edge, or otherwise operating it in irresponsible manner.
- Interfacing new hardware without considering compatibility.
- Overloading the robot above its payload capacity.
- Exposing the robot to wet environments.
- Continuing to run the robot after hair, yarn, string, or any other item is entangled in the robot's axles or wheels.
- All other forms of inappropriate operations.
- Using robot in areas prone to static electricity.
- Read carefully paragraphs marked with caution symbol.

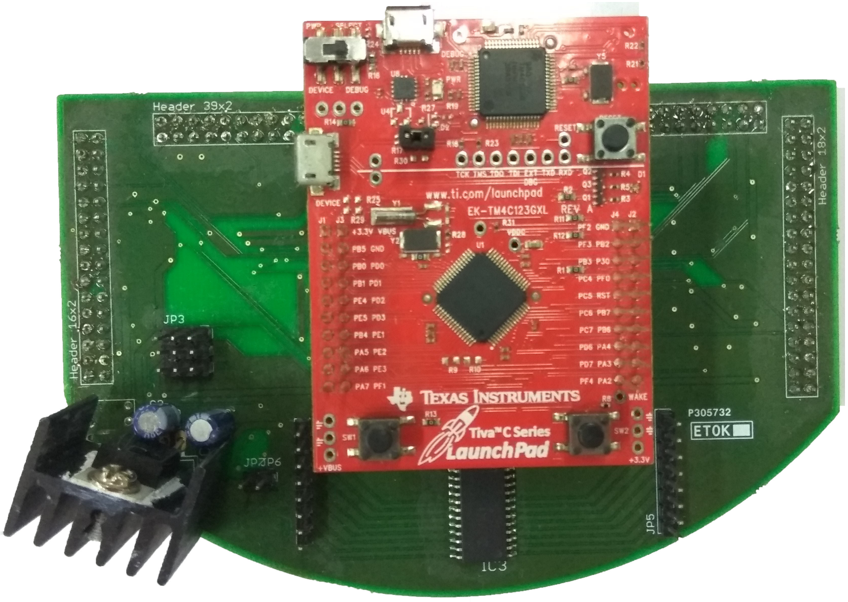


Figure a. Plug and Play Daughter Board

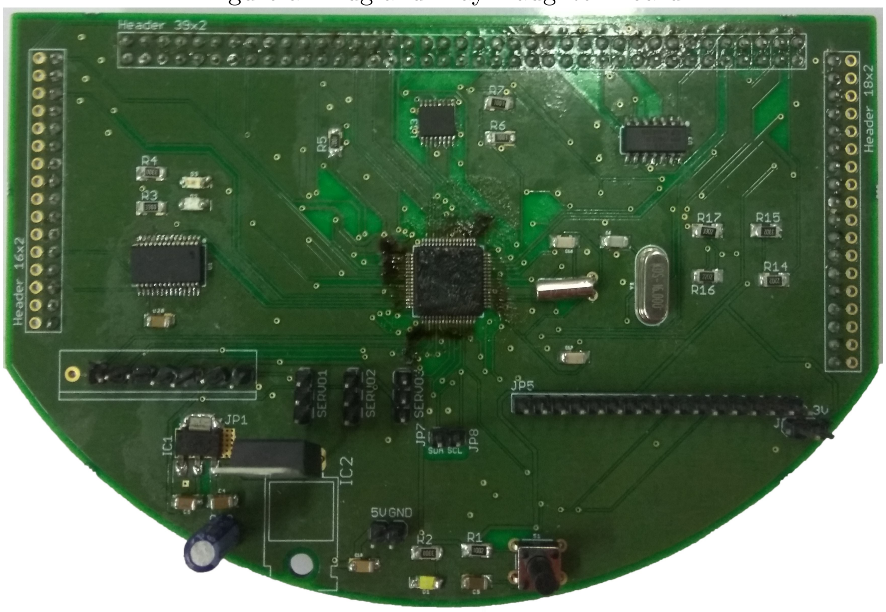


Figure b. uC Daughter Board

4 Tiva Based Daughter Board

There are two daughter boards one based on the Tiva Launchpad(Plug and Play)and other one with the Arm Cortex M4 based microcontroller(uC). Almost all the specification are same unless mentioned otherwise.You can refer to figure no. 1 for pin out of Tiva Launchpad.Tiva Launchpad is Arm Cortex M4 based microcontroller board by Texas Instruments.

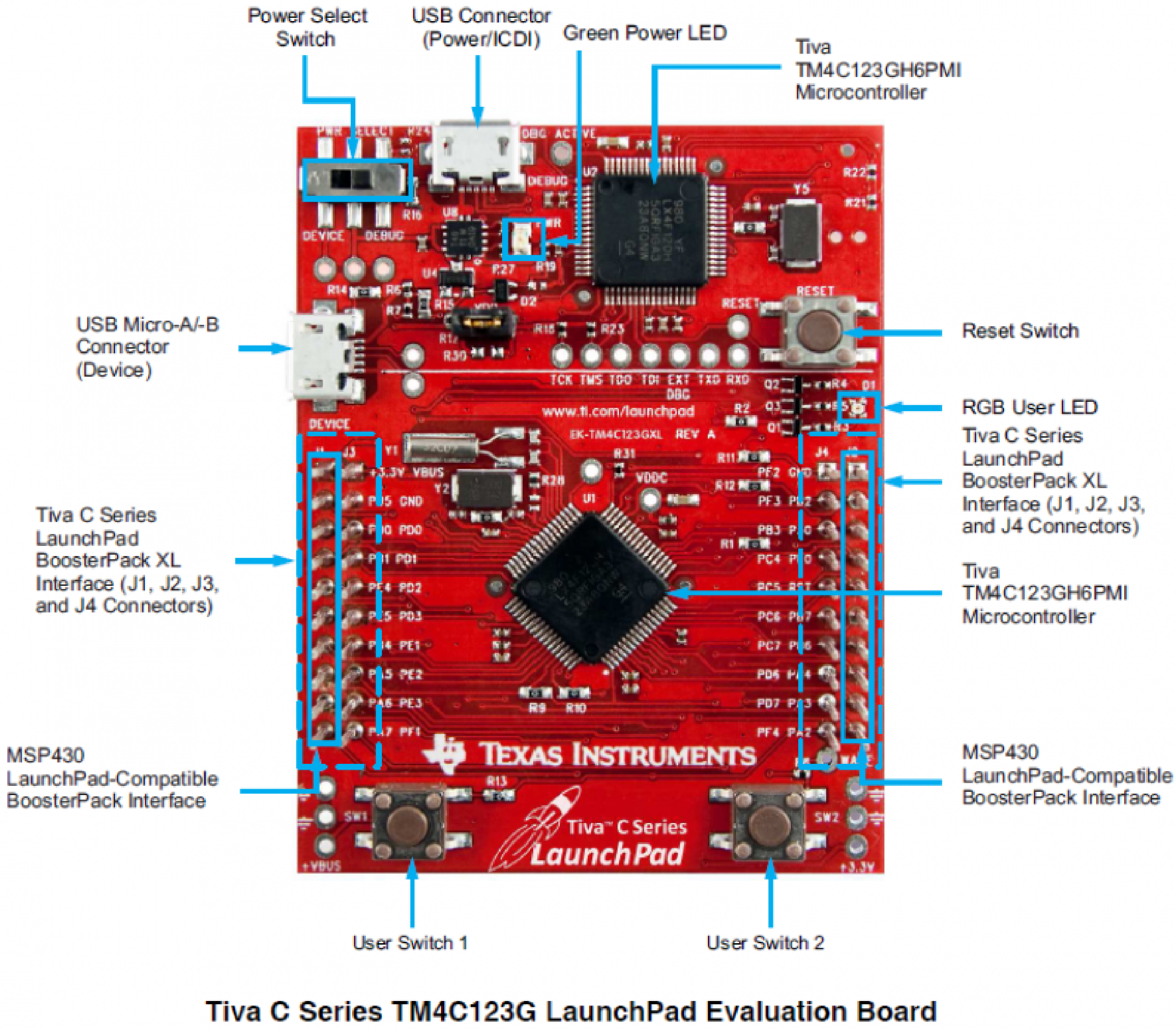


Figure 1.
Picture Courtesy:element14

4.1 Technical Specification

Microcontroller:
TM4C123gh6pm (ARM architecture based Microcontroller)
To know more about the microcontroller please refer to datasheet.

Sensors:
Three white line sensors (extendable to 7)
Five Sharp GP2Y0A02YK IR range sensor (One in default configuration)
Eight analog IR proximity sensors
Two position encoders

Indicators:
2 x 16 Characters LCD
Buzzer

Communication:
USB Communication
Wireless ZigBee Communication (2.4GHZ) (if XBee wireless module is installed)
Bluetooth communication(Can be interfaced on external UART0 available on the board)
Simplex infrared communication (From infrared remote to robot)

I2C Communication

Battery Life:
2 Hours, while motors are operational at 75% of time

Locomotion:
Two DC geared motors in differential drive configuration and caster wheel at front as support
Top Speed: 24 cm / second
Wheel Diameter: 51mm
Position encoder: 30 pulses per revolution
Position encoder resolution: 5.44 mm

5 Hardware Manual:

5.1 Voltage Regulation on the Daughter Board

The voltage source available on the Firebird is 9.6V. But the microcontroller works on 3.3V and the servos can operate upto 6V. So there must be 3 different voltage levels on the board.
The uC based board has 2 voltage regulators one 5V regulator and other 3.3V regulator.In the uC based board the 9.6 volts is regulated at 3.3V to power the microcontroller.Servo motors have different regulator.
The plug and play board has 1 voltage regulator for servo motors only. In the plug and play board the there is an inbuilt voltage regulator that regulated voltage at 3.3V, so it is directly connected connected to 5v, 300mA source.Servo motors have a separate 5V regulator.

5.1.1 Powering Micro-controller

The boards have different powering circuits. In the plug and play board VBUS of Launchpad is connected to 5V source on main board. You can refer to Figure 1.
In the uC based board the 9.6V source available on Pin 29 of main board is regulated to 3.3V. For schematic refer to Figure 2.

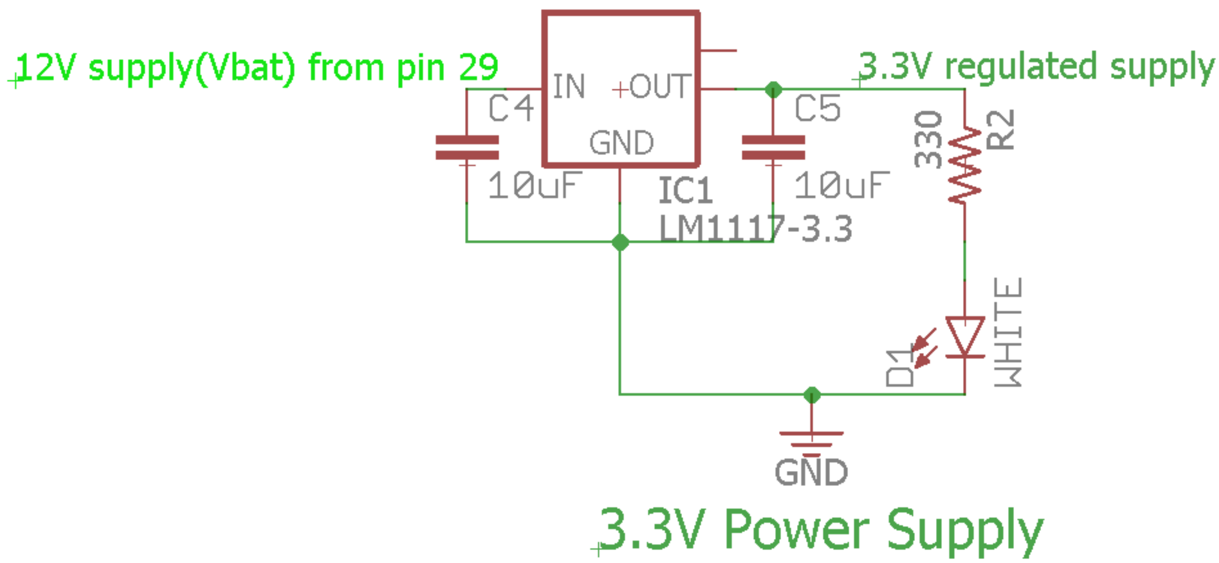


Figure 2. 3.3V Power Supply.

5.1.2 Powering Servos

The servo motor require high current. There is a separate power line for servos taken from Pin 29 and regulated to 5V using the voltage regulator. For schematics refer to Figure 3.

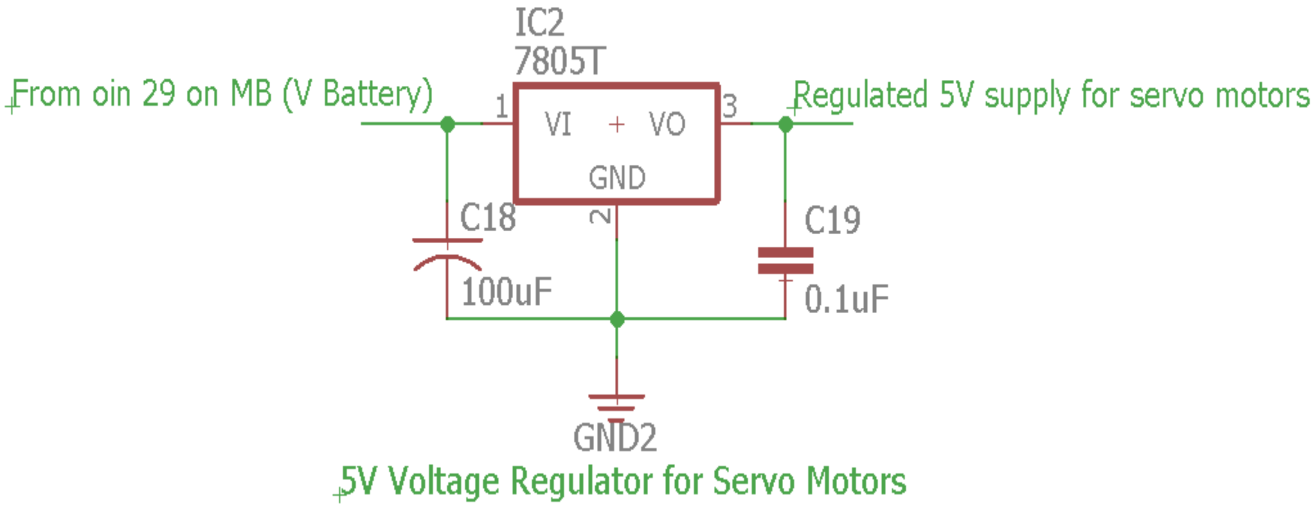


Figure 3. Servo Power Supply.

5.2 Level Converters

The TM4C123G operates at 3.3V and the Firebird operates at 5V. Directly connecting these pins to the TIVA may be fatal. So to interface these sensors, a bidirectional MOSFET based level converter used. The level converter is necessary for mostly for input because 3.3V is consider as level high. On the board Level converter is used for interfacing the position encoders of the motors. For schematic refer to the Figure 4.

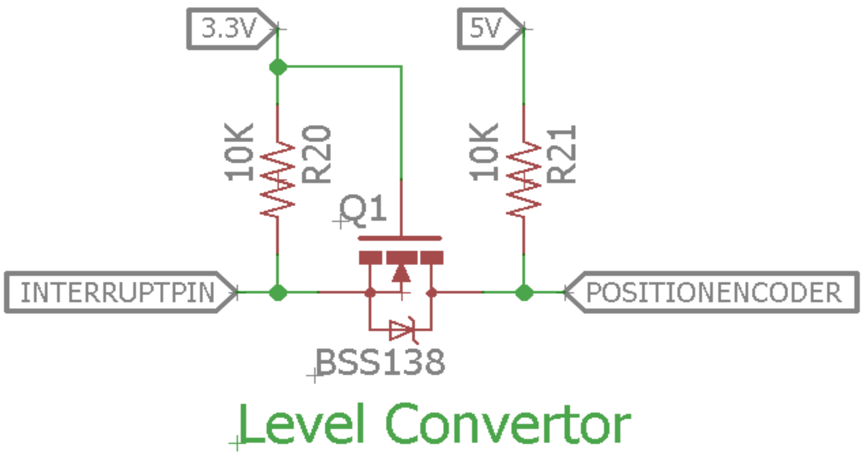


Figure 4. Level Converters.

NOTE: If the user wishes to interface extra sensors using the GPIOs provided on the board, then external level converters have to used if the output of the sensor is above 3.3V.

5.3 Sensors

The daughter board has interfaced 20 sensors present on main board using internal and external ADC.. These sensors are working either on 3.3V or on 5V. Interfacing 3.3V sensors are simple and can be directly connected to the controller. On the other hand 5V can not be directly interfaced so a different approach is taken which will be mentioned in the 5V sensors sub heading.

5.3.1 3.3V sensors

The output white line sensors and IR Proximity sensors vary from 0 to 3.3V. Hence these sensors can be interfaced directly with the microcontroller. Refer the table below for pin connections.

Sensor	Pin(uC)	Pin(Plug and Play)
IR Proximity 1	PE1	PB5
IR Proximity 2	PE3	PD0
IR Proximity 3	PE5	PD3
IR Proximity 4	PE4	PD1
IR Proximity 5	PB5	PE5
IR Proximity 6	External ADC IN6	External ADC IN7
IR Proximity 7	External ADC IN7	PE0
IR Proximity 8	External ADC IN0	External ADC IN0
White Line 1	PD2	PE1
White Line 2	PD1	PE2
White Line 3	PD0	PE3
White Line 4	External ADC IN1	External ADC IN2
White Line 5	External ADC IN2	External ADC IN3
White Line 6	External ADC IN3	External ADC IN4
White Line 7	External ADC IN4	External ADC IN5

5.3.2 5V sensors

Sharp Sensors are the only sensors on board that works on 5V supply. The output of the sharp sensor ranges from 0-5V and according to the output we have a formula to calculate the distance. While uC has VREF as 3.3V so these sensors cannot be directly connected. The approach we followed is to feed the output of the sensor to a buffer and then using a voltage divider convert 0-5 range to 0-3V range. For better understanding refer to the Figure 5 below. There is also a table which tells about the pin connection.

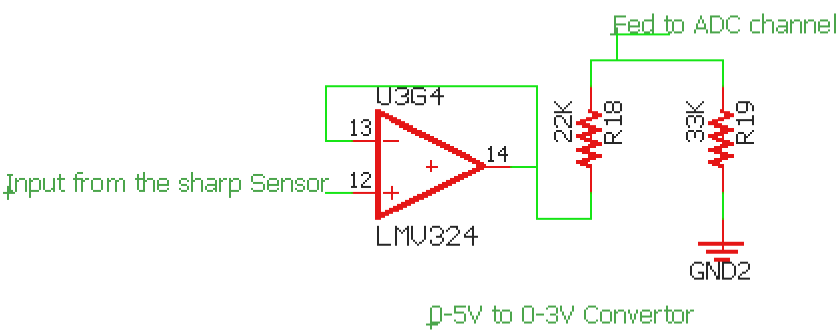


Figure 5. Sharp Sensor Schematic.

Sharp Sensor	Pin(uC)	Pin(Plug and Play)
1	PE0	PB4
2	PE2	External ADC IN1
3	PD3	PD2
4	External ADC IN5	External ADC IN5
5	PB4	PE4

5.4 Port Expander

TM4C123GH6PM has 64 pins out which only 43 are GPIO pins. This limits our application for I/O operations. To increase the number of GPIO and there interrupts we have used I2C compatible a port expander MCP23017. It has 2 PORTS A and B, with each port having 8 Pins.The interrupts on each pin can also be monitored. To read more about it, download the datasheet from here.The schematic of the connection is shown below.Keep in mind that I2C SCL and SDA have already been pulled up using 10K resistor.

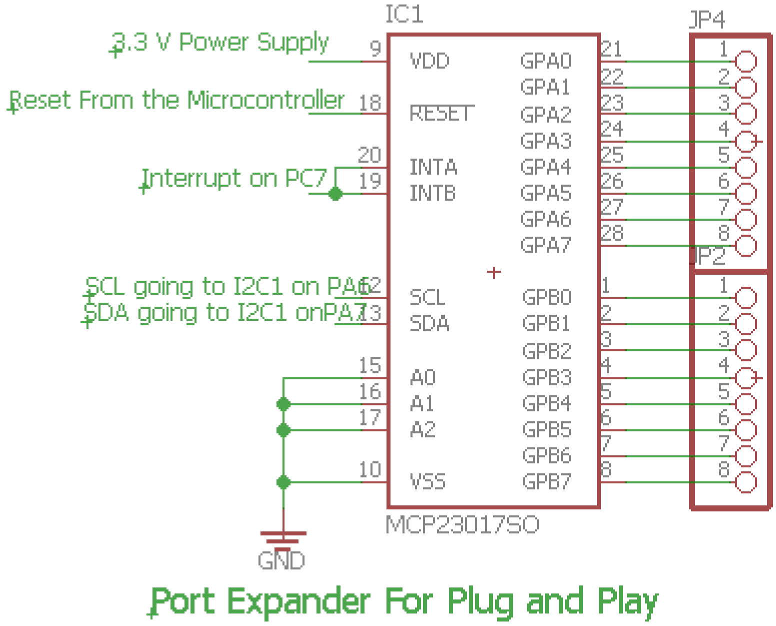


Figure 6. Port Expander for Plug and Play Board.

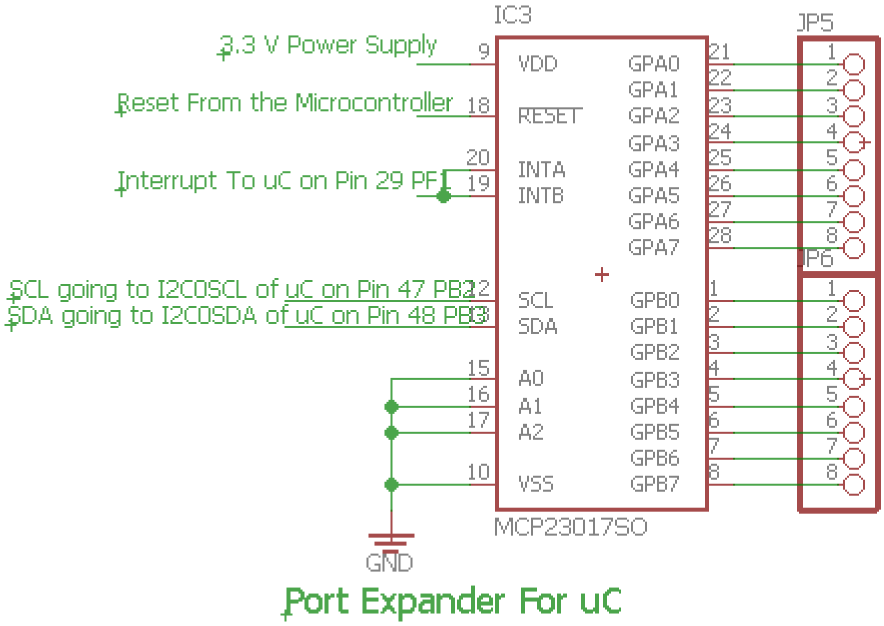


Figure 7. Port Expander for uC Board.

5.5 External ADC

It has already been mentioned that ADC channels on the microcontroller is limited to 12 while we need 20 channels. We have interfaced an external ADC which is also I2C compatible. It has 8 channel with 12 bit resolution.To read more about it, download the datasheet from here.The schematic of the connection is shown below.Keep in mind that I2C SCL and SDA have already been pulled up using 10K resistor.

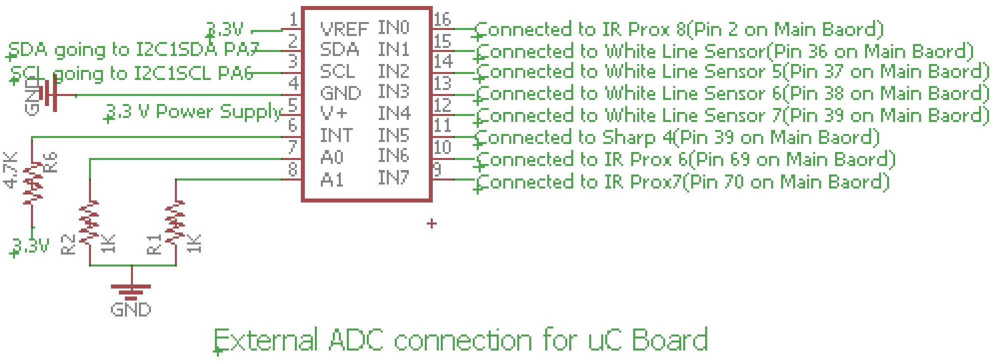


Figure 8. External ADC Connection for uC Board.

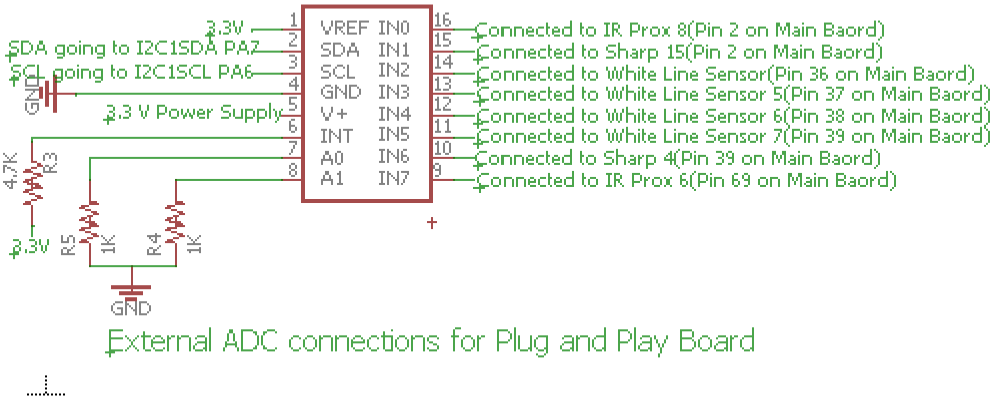


Figure 9. External ADC Connection for Plug and Play Board.

5.6 LCD Interfacing

LCD can be interfaced in 8-bit or 4-bit interfacing mode. In 8-bit mode it requires 3 control lines and 8 data lines. To reduce number of I/Os required, Fire Bird V robot uses 4 bit interfacing mode which requires 2 control lines and 4 data lines. In this mode upper and lower nibble of the data/command byte needs to be sent separately. RW(Read/Write) control line of LCD is grounded so it can only work in write mode.

The EN line is used to tell the LCD that microcontroller has sent data to it or microcontroller is ready to receive data from LCD. This is indicated by a high-to-low transition on this line. To send data to the LCD, program should make sure that this line is low (0) and then set the other two control lines as required and put data on the data bus. When this is done, make EN high (1) and wait for the minimum amount of time as specified by the LCD datasheet, and end by bringing it to low (0) again.

When RS is low (0), data is treated as a command or special instruction by the LCD (such as clear screen, position cursor, etc.). When RS is high (1), data being sent is treated as text data which should be displayed on the screen.

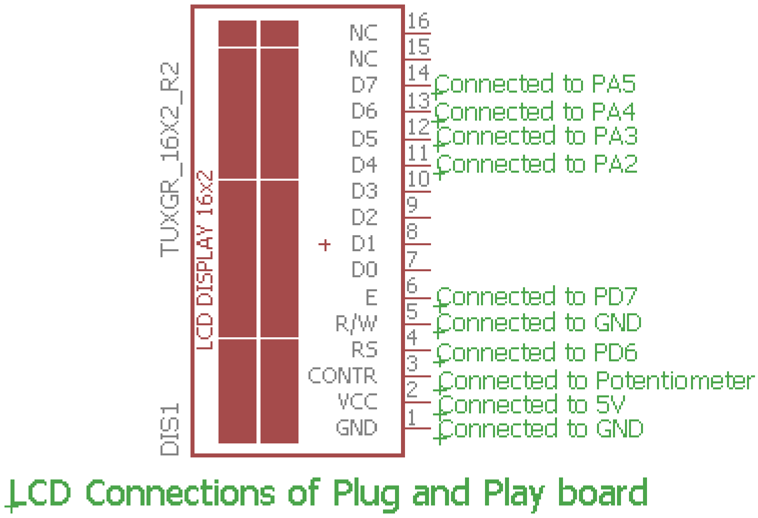


Figure 10. LCD Connections of Plug and Play Board.

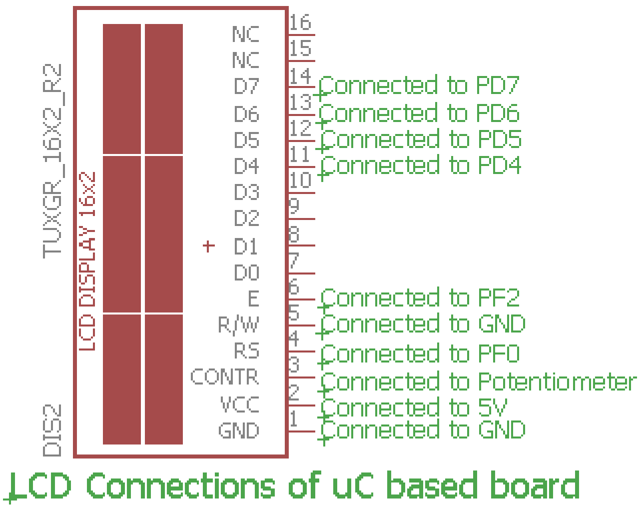


Figure 11. LCD Connections of uC Board.

LCD Pin	Pin(uC)	Pin(Plug and Play)
RS	PF0	PD6
EN	PF2	PD7
DB4	PD4	PA2
DB5	PD5	PA3
DB6	PD6	PA4
DB7	PD7	PA5

5.7 USB Communication

Fire Bird V's main board has USB port socket. Microcontroller accesses USB port via main board socket. All its pins are connected to the microcontroller adapter board via main board's socket connector.FT232 is a USB to TTL level serial converter. It is used for adding USB connectivity to the microcontroller adapter board. With onboard USB circuit Fire Bird V can communicate serially with the PC through USB port without the use of any external USB to Serial converter. Microcontroller socket uses USB port from the main board.
Data transmission and reception is indicated using TX(Green) and RX(Red) LEDs which are located near the FT232 IC. This is only for the uC based board.You can refer to schematic in Figure 12.
Plug and play board has its own USB port on TIVA launcpad.

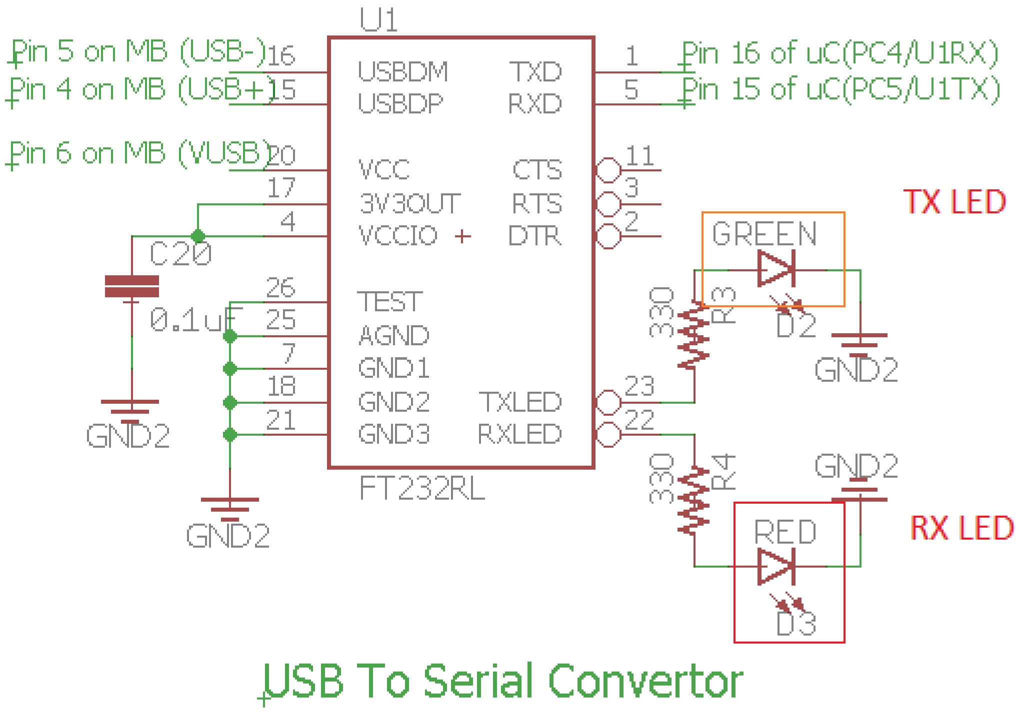


Figure 12. FT232 Connections of uC Board.

5.8 Reset Switch

The Plug and play board makes use of reset button present on the TIVA launchpad. The uC based has a switch connected to the reset the reset pin 38 of the microcontroller. The schematic is given below.

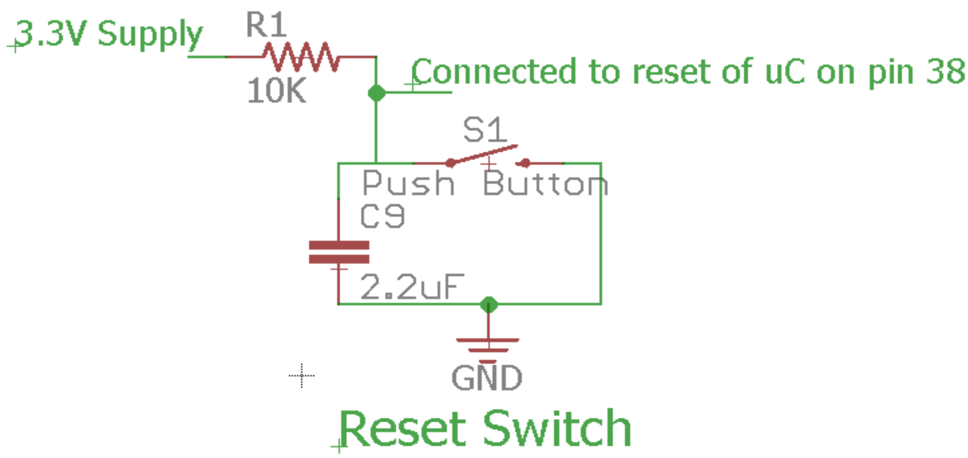


Figure 13. Reset Switch Connections of uC Board.

5.9 Servo Connectors

The microcontroller board has three Servo connectors. It can be used for driving servo motors of camera pod or any other robotic mechanism. Power for the servo connector is provided by the "5V servo supply" voltage regulator. Both the board have different PWM pins for servo which can be seen from the schematic.

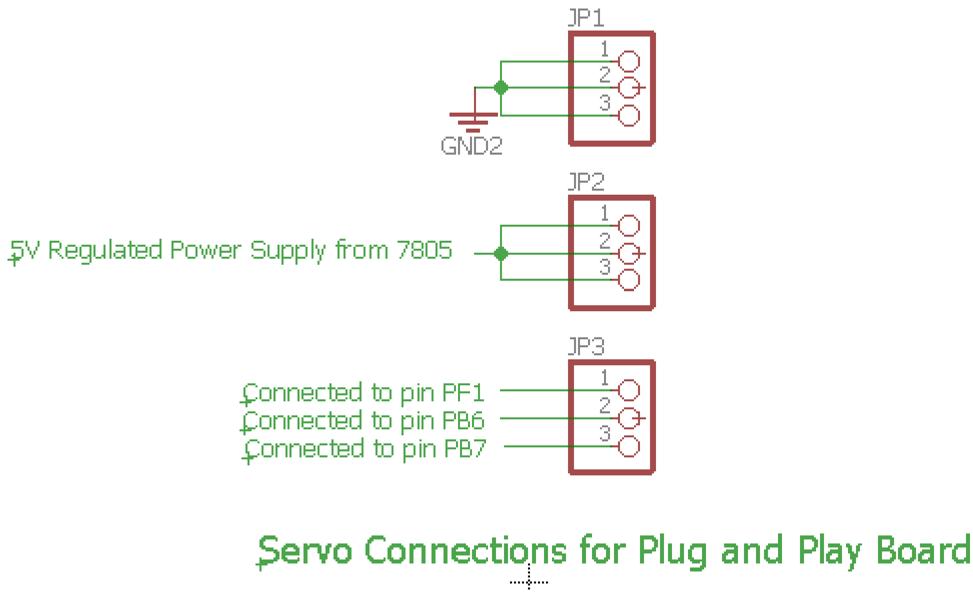


Figure 14. Servo Motors Headers Connections of Plug and Play Board.

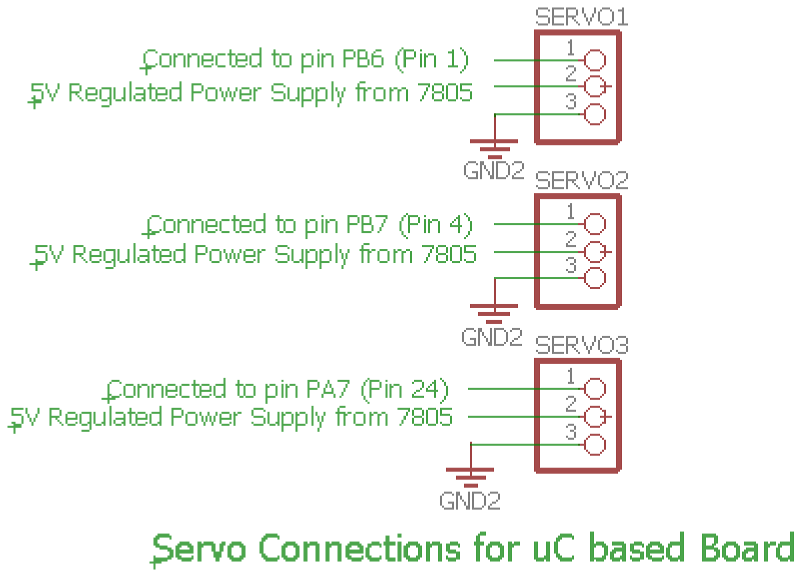


Figure 15. Servo Motors Header Connections of uC Board.

5.10 TM4C123GH6PM Micro-controller:

TM4C123GH6PM is ARM Cortex M4 microcontroller bt Texas Instruments. It is used by Texas Instruments for Tiva Launchpad. The microcontroller is relatively advance and has following features:

5.10.1 Feature of TM4C123GH6PM

- 32-bit ARM Cortex M4F architecture optimized for small-footprint embedded applications
- 80-MHz operation
- 16-bit SIMD vector processing unit
- Harvard architecture characterized by separate buses for instruction and data
- Deterministic, high-performance interrupt handling for time-critical applications
- Enhanced system debug with extensive breakpoint and trace capabilities
- Ultra-low power consumption with integrated sleep modes

Schematic Of the connections is shown below.

Figure 16. uC Connections From 1-32.

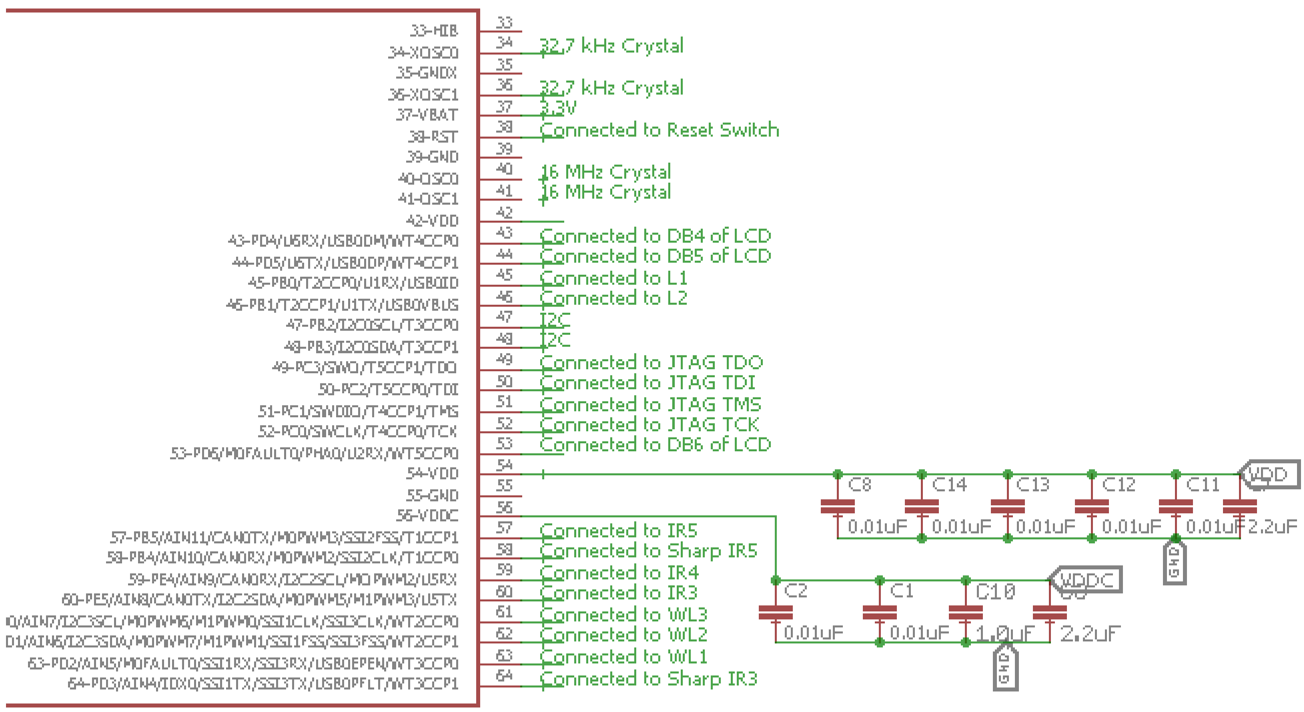


Figure 17. uC Connections From 33-64.

5.11 Pin Functionality

5.11.1 Pin of uC

uC Pin No.	Pin	Complete Pin Connections	Main Board
1	PB6	Servo Motor 1	
2	VDDA	VDD filtered through capcitors	
3	GNDA	Ground	3
4	PB7	Servo Motor 2	
5	PF4	Pin 53 Right Motor 1	
6	PE3	IR proximity Sensor 2	16
7	PE2	Output of Second OpAmp of lm324	
8	PE1	IR Proximity Sensor 1	12
9	PE0	output of First OpAmp of lm324	
10	PD7	DB7 of LCD Data	28
11	VDD	VDD filtered through capcitors	
12	GND	Ground	3
13	PC7	Zigbee Rx	13
14	PC6	Zigbee Tx	14
15	PC5	FT232 Rx	
16	PC4	FT232 Tx	
17	PA0	External UART Rx	
18	PA1	External UART Tx	
19	PA2	Buzzer	71
20	PA3	Right Position Encoder Interrupt	63
21	PA4	Left Position Encoder Interrupt	64
22	PA5	Right Motor 2	55
23	PA6	Right Motor PWM	54
24	PA7	Servo Motor 3	
25	VDDC	Connected to VDDC on pin 56	
26	VDD	VDD filtered through capcitors	
27	GND	Ground	
28	PF0	RS of LCD	22
29	PF1	INT A and B of to GPIO expander shorted and connected	
30	PF2	24 EN of LCD	24
31	PF3	Left Motor PWM	50
32	WAKE	Ground	3
33	HIB	NC	
34	XOSC0	32.7 KHz crystals(One End)	
35	GNDX	Cap to crystal	
36	XOSC1	32.7 KHz crystals(Other End)	
37	VBAT	3.3 Volts	
38	RST	Reset Switch	
39	GND	Ground	
40	OSC1	16 MHz crystal(One end)	
41	OSC1	16 MHz crystal(Other end)	
42	VDD	VDD filtered through capacitors	
43	PD4	DB4 Of LCD	26
44	PD5	DB5 of LCD	25
45	PB0	Left Motor 1	51
46	PB1	Left Motor 2	52
47	PB2	I2C ADC SCL	
48	PB3	I2C ADC SDA	
49	PC3	JTAG TDO	
50	PC2	JTAG TDI	
51	PC1	JTAG TMS	
52	PC0	JTAG TCK	
53	PD6	DB6 Of LCD	27
54	VDD	VDD filtered through capcitors	

55	GND	Ground	
56	VDDC	Connected to VDDC on pin 25	
57	PB5	IR Proximity Sensor 5	46
58	PB4	Output of First OpAmp of lm358	
59	PE4	IR Proximity Sensor 4	43
60	PE5	IR Proximity Sensor 3	42
61	PD0	White Line Sensor 3	32
62	PD1	White Line Sensor 2	31
63	PD2	White Line Sensor 1	30
64	PD3	Output of Third OpAmp of lm324	

5.11.2 Robot Main Board Connections

Main Board Pin Out	Pin Name	Functionality	PIN on uC DB	Pin on Pluggable DB
1	Current sensor	Current sense analog value	Not Using	Not Using
2	IR Proximity sensor 8	IR Proximity sensor 8 analog value	External ADC INT0	External ADC INT0
3	GND	Ground	Ground	Ground
4	DATA+	USB connection going to the ATMEGA2560 USB connection with uC	PC4	
5	DATA-	microcontroller via FT232 USB to serial USB connection with uC	PC5	
6	VCC	USB converter. Connect TO VCC of FT232		
7	5V System	"5V System Voltage. Can be used for powering up any digital device with current limit of 400mA."		
8	5V System	"5V System Voltage. Can be used for powering up any digital device with current limit of 300mA."		
9	5V System	"5V System Voltage. Can be used for powering up any digital device with current limit of 300mA."		
10	5V System	"5V System Voltage. Can be used for powering up any digital device with current limit of 400mA."		
11	SHARP IR Range Sensor 1	Analog output of Sharp IR range Sensor 1	PE0(lm324 1)	PB4
12	IR Proximity Sensor 1	Analog output of IR Proximity sensor 1	PE1	PB5
13	XBee RXD	XBee wireless module Serial data in	PC7	PB1
14	XBee TXD	XBee wireless module Serial data out	PC6	PB0
15	SHARP IR Range Sensor 2	Analog output of Sharp IR range sensor 2	PE2(lm324 2)	External ADC INT1
16	IR Proximity Sensor 2	Analog output of IR Proximity sensor 2	PE3	PD0
17	RSSI	To capture the RSSI signal		
18	MOSI	MOSI of the Controller/NC create extra expansion headers		
19	MISO	MISO of controller/NC create extra expansion headers		
20	SCK	SCK of the controller/NC create extra expansion headers		
21	SSI	SS of the controller/ NC create extra expansion headers		
22	RS	connected to RS of LCD normal I/O	PF0	PD6
23	RW	connected to RW of LCD normal I/O	GND	GND
24	EN	connected to EN of LCD normal I/O	PF2	PD7
25	DB5	data pin of LCD normal I/O	PD5	PA3
26	DB4	data pin of LCD normal I/O	PD4	PA2
27	DB6	data pin of LCD normal I/O	PD6	PA1
28	DB7	data pin of LCD normal I/O	PD7	PA0

29	V Battery System	ADC to check the level of battery voltage		
30	WL1	Analog output of white line sensor 1	PD2	PE1
31	WL2	Analog output of white line sensor 2	PD1	PE2
32	WL3	Analog output of white line sensor 3	PD0	PE3
33	"Sharp IR Sensors 1and 5 Disable"			
34	IR Proximity Sensor Disable			
35	5V System	"5V system Voltage. Can be used for powering up any digital device. Current Limit: 400mA."		
36	WL4	Analog output of white line sensor 4	External ADC INT1	External ADC INT2
37	WL5	Analog output of white line sensor 5	External ADC INT2	External ADC INT3
38	WL6	Analog output of white line sensor 6	External ADC INT3	External ADC INT4
39	WL7	Analog output of white line sensor 7	External ADC INT4	External ADC INT5
40	White Line Sensors Disable			
41	Sharp IR Range Finder 3	Analog output of Sharp IR range sensor 3	PD3 (lm 324 3)	PD2
42	IR Proximity Sensor 3	Analog output of IR Proximity sensor 3	PE5	PD3
43	IR Proximity Sensor 4	Analog output of IR Proximity sensor 4	PE4	PD1
44	Sharp IR Range Finder 4	Analog output of Sharp IR range sensor 4	in 5 ex (lm 324 5)	External ADC INT6
45	Sharp IR Range Finder 5	Analog output of Sharp IR range sensor 5	PB4 (lm358 1)	PE4
46	IR Proximity Sensor 5	Analog output of IR Proximity sensor 5	PB5	PE5
47	C11	motor not present		
48	C1	PWM not present		
49	C12	not present		
50	PWM L	left motor PWM(timer pin in PWM mode)	PF3	PF2
51	L1	left motor pin1 normal I/O	PB0	PF3
52	L2	left motor pin2 normal I/O	PB1	PB3
53	R1	right motor pin1 normal I/O	PF4	PC4
54	PWM R2	right motor PWM(timer pin in PWM mode)	PA6	PC5
55	R2	right motor pin2	PA5	PC6
56	NC			
57	NC			
58	NC			
59	NC			
60	NC			
61	NC			
62	Position encoder left	Output of Left position encoder (0-5V) PA4	PB2	
63	Position encoder right	Output of Right position encoder (0-5V) PA3	PF0	
64	position enocder C2	Output of C2 position encoder (0-5V)		
65	Position encoder C1	Output of C1 position encoder (0-5V)		
66	C22	NC		
67	C21	NC		
68	C2	PWM	NC	
69	IR Prox6	Analog output of IR Proximity sensor 6 External ADC	INT6	External ADC INT7
70	IR Prox7	Analog output of IR Proximity sensor 7 External ADC	INT7	PE0
71	Buzzer	Input, V¿0.65V turns on the Buzzer	PA2	PF4
72	DAC Out	NC		
73	RS232 TX	NC		
74	RS232 RX	NC		

5.11.3 Pin Connection Of Plug And Play Board

Pin Name	Pin Connection on Main Board	Function
PA0		Used for Programming
PA1		Used for Programming
PA2	26	DB4 of LCD
PA3	27	DB5 of LCD
PA4	28	DB6 of LCD
PA5	29	DB7 of LCD
PA6		I2C
PA7		I2C
PB0	14	Zigbee Tx
PB1	13	Zigbee RX
PB2	62	Position encoder of left motor
PB3	52	L2
PB4	11	Sharp IR1
PB5	12	IR 1
PB6		Servo
PC0		
PC1		
PC2		
PC3		
PC4	53	R1
PC5	54	PWM of right motor
PC6	55	R2
PC7		Interrupt of port expander
PD0	16	IR 2
PD1	43	IR Prox 4
PD2	41	Sharp IR 3
PD3	42	IR Prox 3
PD4		
PD5		
PD6	22	RS of LCD
PD7	24	EN of LCD
PE0	70	IR 7
PE1	30	WL1
PE2	31	WL2
PE3	32	WL3
PE4	45	Sharp IR 5
PE5	46	IR 5
PE6		
PE7		
PF0	63	Position encoder of right motor
PF1		Servo
PF2	50	PWM of left motor
PF3	51	L1
PF4	71	Buzzer

6 Software Manual:

6.1 Code Composer Studio:

Code Composer Studio is an Integrated development environment(IDE) that supports microcontroller by Texas Instruments. It is used for writing C/C++ codes for the microcontroller. It also allows the features of real time debugger that proves very advantageous in case of debugging the algorithm. about CC Studio

6.1.1 Download CC Studio:

At the time of writing this document Version 7 was the latest one. You can check for the latest at Download CCS.There will be two installer files.The web installer will require Internet access throughout the installation period. If the web installer version doesn't work for you or you face some issues download, unzip and run the offline version. The offline download will be much larger than the installed size of CCS since it includes all the possible supported hardware.

6.1.2 Installing C C Studio:

After the installer has started follow the steps mentioned below:

1. Accept the Software License Agreement and click Next.

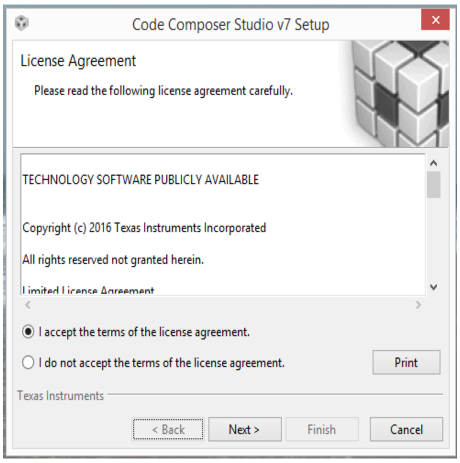


Figure 18.

2. Select the destination folder and click next.

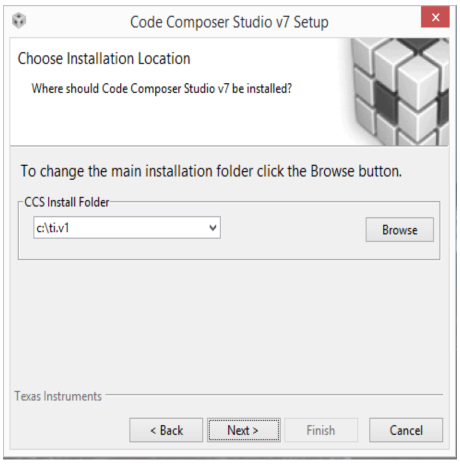


Figure 19.

3. Select the processors that your CCS installation will support. You must select "TM4C12X Arm Cortex M4". You can select other architectures, but the installation time and size will increase.

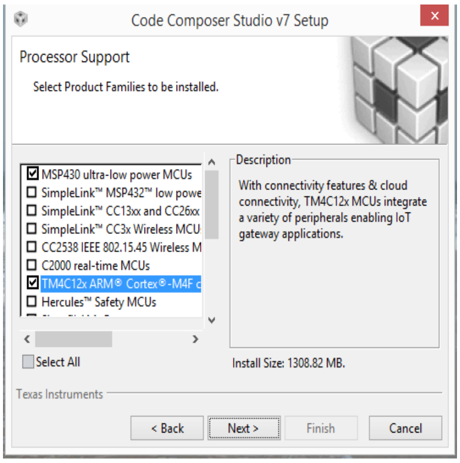


Figure 20.

4. Select debug probes and click finish

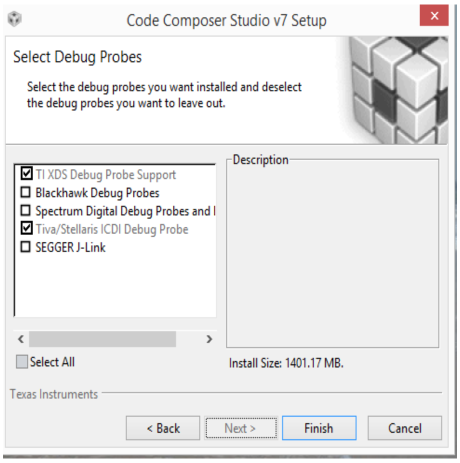


Figure 21.

5. The installer process should take 15 - 30 minutes, depending on the speed of your connection. The offline installation should take 10 to 15 minutes. When the installation is complete, uncheck the "Launch Code Composer Studio v7" checkbox and then click Finish.There are several additional tools that require installation during the CCS install process. Click "Yes" or "OK" to proceed when these appear.

6. Install TivaWare for C Series (Complete). Download and install the latest full version of TivaWare from: TivaWare. The filename is SW-TM4C-x.x.exe . This workshop was built using version 1.1. Your version may be a later one. If at all possible, please install TivaWare into the default location.

You can find additional information at these websites:
Main page: www.ti.com/launchpad
Tiva C Series TM4C123G LaunchPad:
http://www.ti.com/tool/ek-tm4c123gxl
TM4C123GH6PM folder:
http://www.ti.com/product/tm4c123gh6pm
BoosterPack webpage: www.ti.com/boosterpack
LaunchPad Wiki:
www.ti.com/launchpadwiki

For understanding the launchpad properly and to learn more about Tiva it is strongly recommended to go through the webpage TIva Worshops and download and read the workbook

6.1.3 Create a New Project

To create new project follow the steps mentioned:

1. Click File then New and then CCS Projects

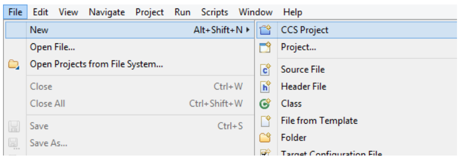


Figure 22.

2. Select Target and connection as shown in the photo. Give a name to your project and save in a location.Click Finish. A main.c file will be open

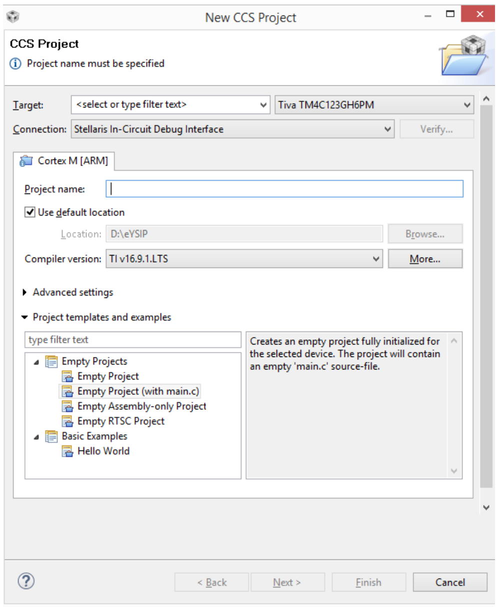


Figure 23.

6.1.4 Add Path and Build Variables

The path and build variables are used for:

- Path variable – when you ADD (link) a file to your project, you can specify a ”relative to” path. The default is PROJECT_LOC which means that your linked resource (like a .lib file) will be linked relative to your project directory.
- Build variable – used for items such as the search path for include files associated with a library – i.e. it is used when you build your project.

Variables can either have a PROJECT scope (that they only work for this project) or a WORKSPACE scope (that they work across all projects in the workspace). In the next step, we need to add (link) a library file and then add a search path for include files. First, we'll add these variables MANUALLY as WORKSPACE variables so that any project in your workspace can use the variables. Refer to the workbook by TI for adding as PROJECT

6.1.4.1 Adding a Path Variable

To add a path variable,:

- Right-click on your Window Tab and select Preference.

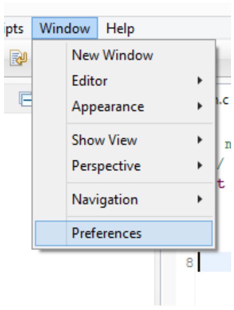
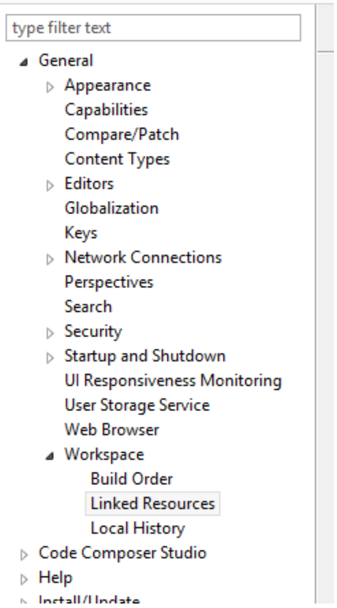


Figure 24.

- Expand General list in the upper left-hand corner as shown and then expand the Resource list and click on Linked Resources: We want to add a New variable to specify exactly where you installed TivaWare.



- Click New
- When the New Variable dialog appears, type TIVAWARE_INSTALL for the name.

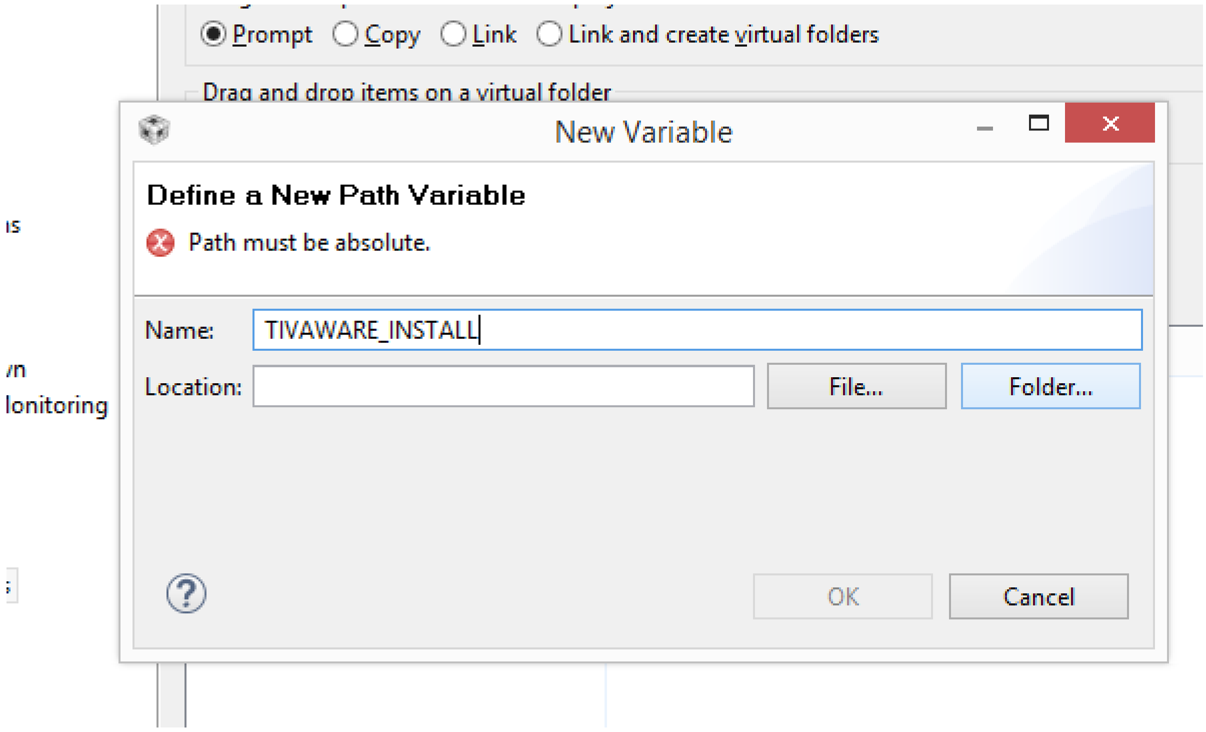


Figure 25.

- For the Location, click the Folder… button and navigate to your TivaWare installation. Click on the folder name and then click OK.

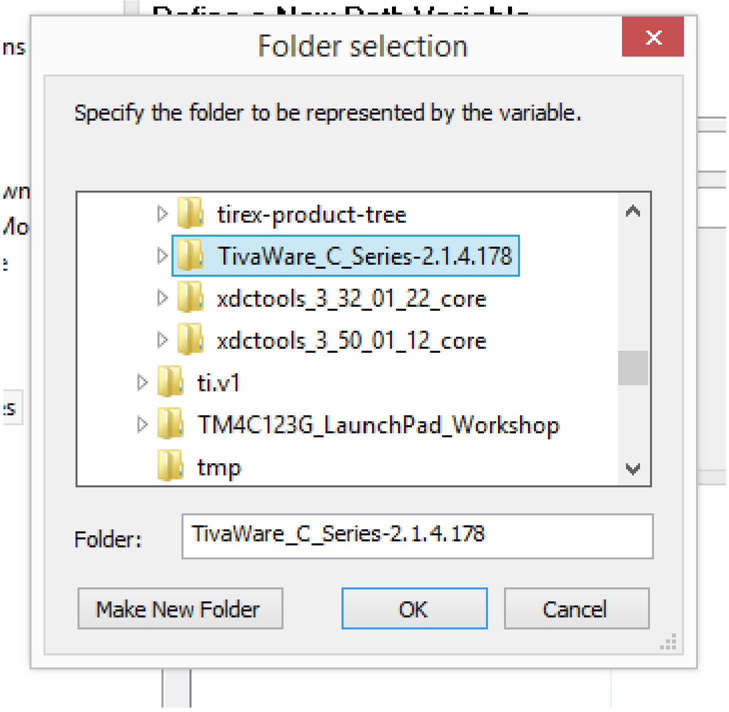


Figure 26.

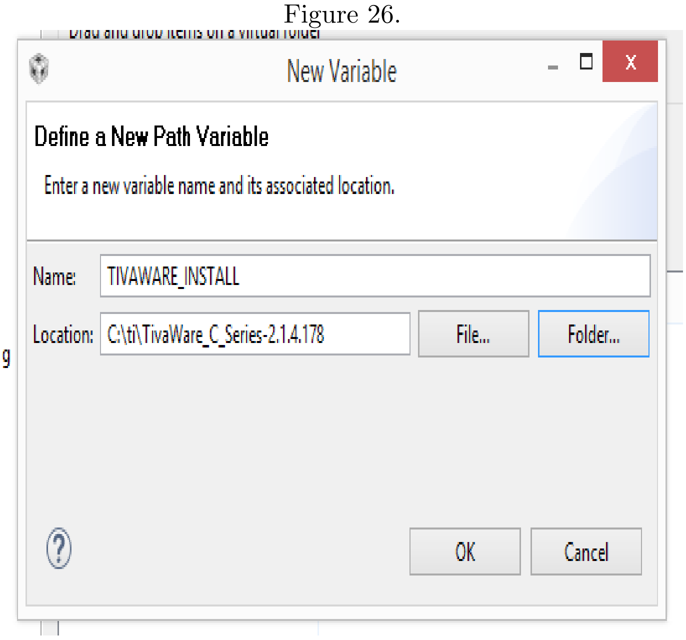


Figure 27.

- Click OK. You should see your new variable listed in the Variables list.

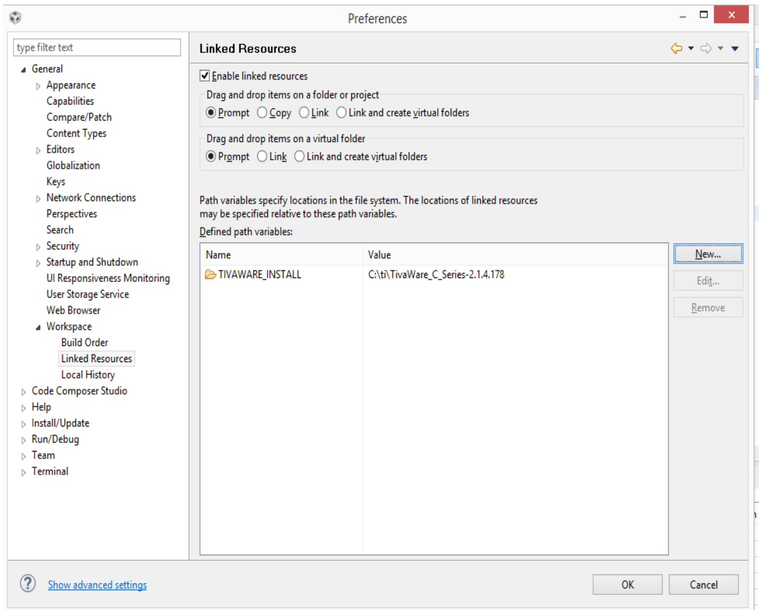


Figure 28.

6.1.4.2 Adding a Build Variable

Now let's add a build variable that we will use in the include search path for the INCLUDE files associated with the TivaWare driver libraries.

- Click on Code Composer Studio Build and then the Variables tab:

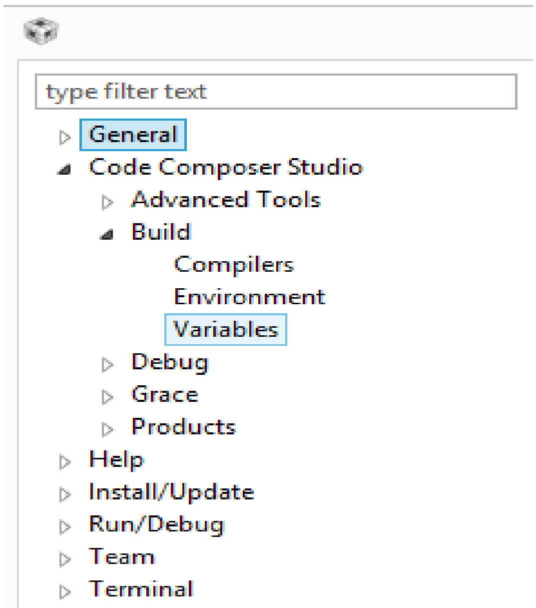


Figure 29.

- Click the Add button. When the Define a New Build Variable dialog appears, insert TIVAWARE_INSTALL into the Variables name box.

- Change the Type to Directory and browse to your Tivaware installation folder.

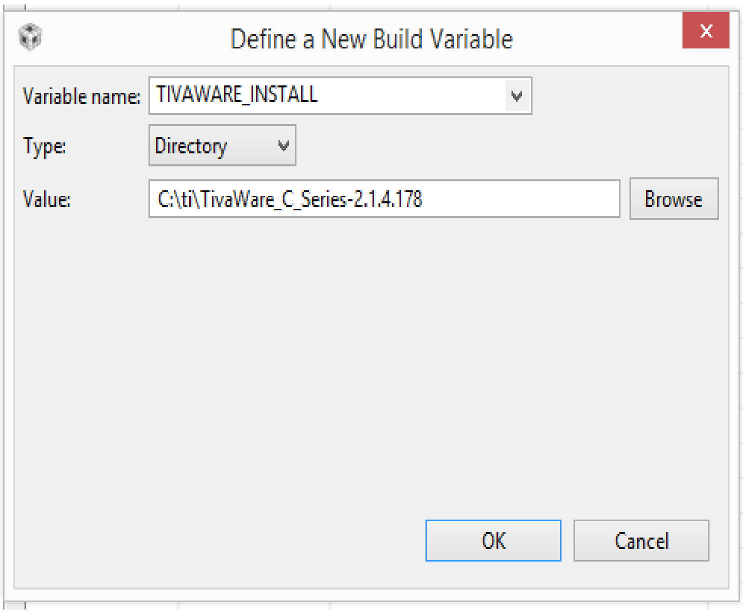


Figure 30.

- Click OK.
- Click OK again to save and close the Build Properties window.

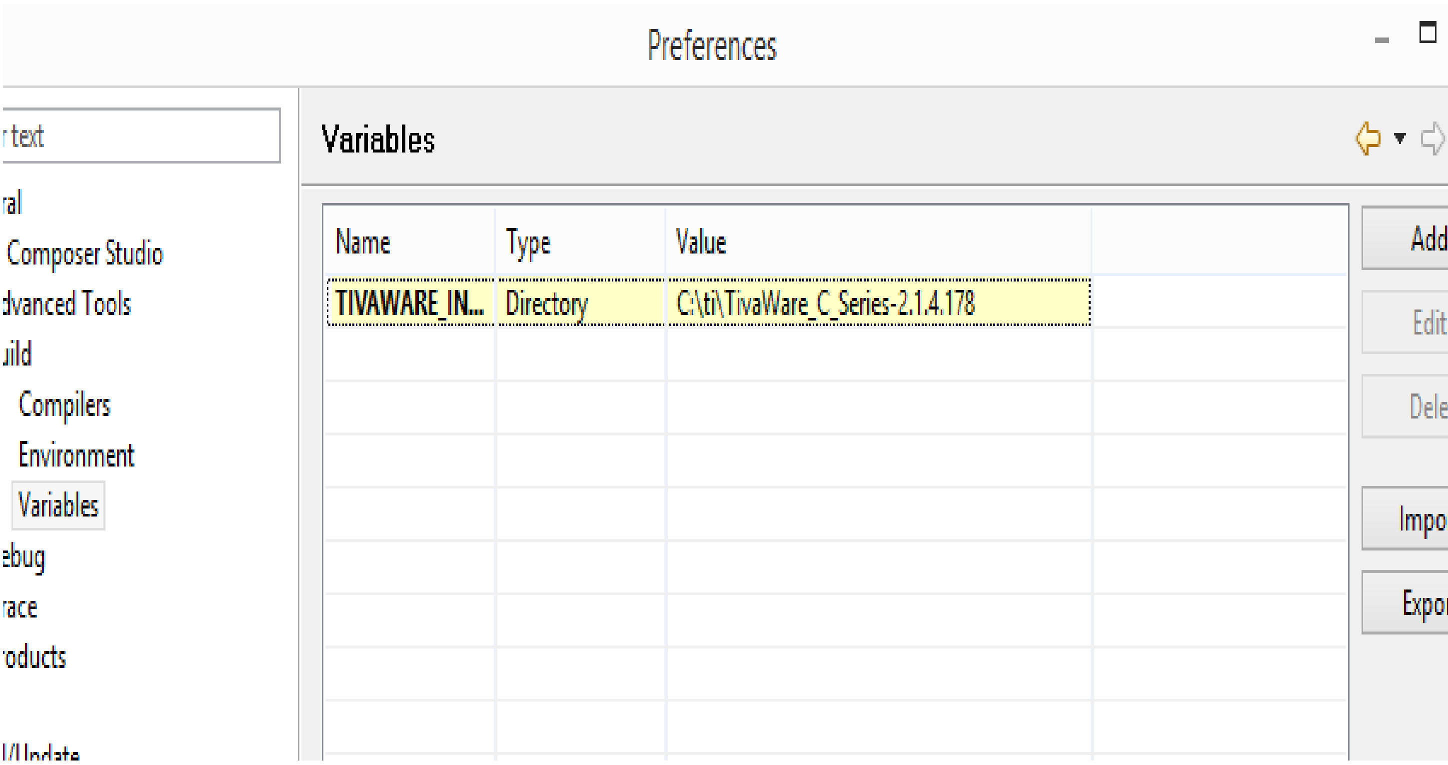


Figure 31.

6.1.4.3 Adding driver.lib

We have to add the TivaWare driverlib.lib object library.

Right Click on Project, select Add Files and Navigate to:
C:/TI/TivaWare_C_Series-1.1/driverlib/ccs/Debug/driverlib.lib

and click Open. The File Operation dialog will open

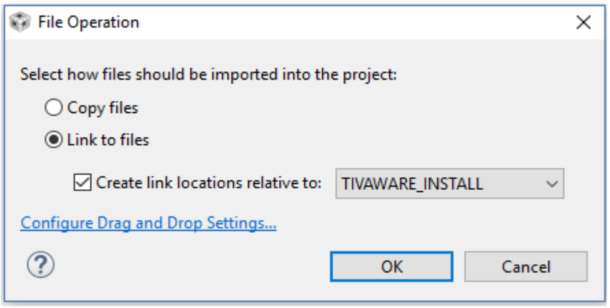


Figure 32.

Use the TIVAWARE_INSTALL path variable you created earlier. This means that the LINK (or reference to the library) file will be RELATIVE to the location of the TivaWare installation. If you hand this project to someone else, they can install the project anywhere in the file system and this link will still work. If you choose PROJECT_LOC, you would get a path that is relative to the location of your project and it would require the project to be installed at the same "level" in the directory structure. Another advantage of this approach is that if you wanted to link to a new version, say TivaWare_C_Series-1.2, all you have to do is modify the variable to the new folder name.

6.1.4.4 Build, Load, and Run

Assure that Daughter Board is connected to the laptop. Build and load your project to the TM4C123GH6PM flash memory by clicking the Debug button. If you ever want to build the project without loading it, click the HAMMER (Build) button. Click the Resume button or press the F8 key on your keyboard.

Figure 33.